

# PATENT ABSTRACTS OF JAPAN

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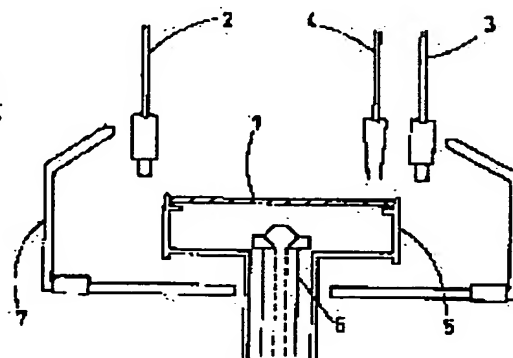
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## (54) METHOD OF CLEANING SUBSTRATE AND APPARATUS FOR CLEANING SUBSTRATE

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To obtain a low-temperature cleaning method for semiconductor substrates, whereby the apparatus can be downsized, a high-concentration chemical solution is economized, the amount of pure water consumed is reduced, and mutual contamination is caused less.

**SOLUTION:** The apparatus comprises a rotatable substrate placing table 5 onto which a substrate 1 is fixed, means 2 and 6 for purging an aqueous solution of dissolved hydrogen prepared by adding hydrogen gas to pure water onto one surface of a substrate 1, ultrasonic wave supplying means for supplying ultrasonic waves to the purged aqueous solution of dissolved hydrogen, and pure water purging means 3 for purging pure water onto both the surface and backside of the substrate 1. By purging the room-temperature aqueous solution of dissolved hydrogen to which ultrasonic vibrations are applied onto the substrate 1, particles and contaminants on the substrate 1 can be removed by the micro-bubbling effect of hydrogen. Since this can be done at room temperature, contamination caused by the evaporation of a chemical solution can be reduced. Further, the traditional batch dipping system wherein substrates are dipped into a chemical solution is replaced with a single wafer cleaning system, whereby the amount of the aqueous solution of dissolved hydrogen and pure water consumed can be reduced, and the apparatus can also be downsized.



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**CLAIMS**

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[Claim(s)]

[Claim 1] The substrate washing approach which includes the process which carries out the regurgitation of said dissolved hydrogen water to the front face of said substrate, and the process which removes discharge and said dissolved hydrogen water for pure water to said substrate, impressing a supersonic wave to the dissolved hydrogen water which was made to rotate a substrate and added hydrogen gas to pure water.

[Claim 2] The substrate washing approach according to claim 2 that the hydrogen concentration of dissolved hydrogen water is 1.0–1.5 ppm.

[Claim 3] The substrate washing station equipped with the pivotable substrate installation base where a substrate is fixed, the dissolved hydrogen water regurgitation means which carries out the regurgitation of the dissolved hydrogen water which added hydrogen gas to pure water to one front face of said substrate, and an ultrasonic supply means to supply a supersonic wave to said dissolved hydrogen water which carries out the regurgitation.

[Claim 4] The substrate washing station equipped with the pivotable substrate installation base where a substrate is fixed, the dissolved hydrogen water regurgitation means which carries out the regurgitation of the dissolved hydrogen water which added hydrogen gas to pure water to the front face and rear face of said substrate, and an ultrasonic supply means to supply a supersonic wave to the dissolved hydrogen water which carries out the regurgitation to the front face and rear face of said substrate.

[Claim 5] The substrate washing station [ equipped with the pure-water regurgitation means which carries out the regurgitation of the pure water to the front face and rear face of a substrate ] according to claim 4 or 5.

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[Translation done.]

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**DETAILED DESCRIPTION**

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the substrate washing approach about washing of a semi-conductor substrate, and a substrate washing station.

[0002]

[Description of the Prior Art] Although washing before oxidation / heat treatment of a semi-conductor substrate, and film deposition etc. to perform has various things, it has the washing method of the style which packs dozens of substrates called an RCA process as what is generally used widely, and is dipped in batch. The washing method of this RCA process is explained as an example of the conventional technique, referring to a drawing.

[0003] Drawing 2 is drawing showing the general configuration of a series of cleaning tanks used for an RCA process. A flush tank puts in a high concentration drug solution (ammonia / hydrogen-peroxide-solution mixed liquor, or a sulfuric acid / hydrogen-peroxide-solution mixed liquor), uses it by heating at high temperature (usually 70 degrees C - 80 degrees C or 130 degrees C - 140 degrees C), and each flush tank is distinguished with the washed ingredient matter formed on the semi-conductor substrate. For example, 8 is the mixed drug solution tub of the organic substance, and a sulfuric acid/hydrogen peroxide solution (130 degrees C - 140 degrees C) aiming at metal removal. the organic substance -- for example, Usher -- the second half of processing -- a conductor -- the resist remainder which remained to the substrate corresponds. It is an aiming at chemical oxide removal fluoric acid [ 9 considered as the rinse tank after drug solution processing, and / 10 ] tub. Chemical oxide says the thin oxide film which grows up to be a front face here, when a semi-conductor substrate is processed with drug solutions of an oxidizing quality, such as a sulfuric acid/hydrogen peroxide solution.

[0004] 11 is a rinse tank after fluoric acid processing, and, as for an aiming at chemical oxide removal fluoric acid [ the mixed liquor tub of ammonia / hydrogen peroxide solution / pure water (70 degrees C - 80 degrees C) aiming at the particle removal in which 12 adhered to the semi-conductor substrate front face, and 13 considered as the rinse tank after drug solution processing, and / 14 ] tub, and 15, the last rinse tank after fluoric acid processing and 16 are the spin dryers for desiccation.

[0005] With the configuration of drawing 2, it can divide into two washing processings generally. One is a process which it begins from processing by the flush tank 8, and the process and others which remove and wash the contamination on the semi-conductor substrate front face finished with a flush tank 11 etc. begin from processing by the flush tank 12, and is finished with a flush tank 15 and which mainly performs particle removal. Although various kinds of \*\* are arranged in as explained above, the sequence put in order in consideration of the class of semiconductor device, the washing purpose, operability, etc. is changed suitably.

[0006]

[Problem(s) to be Solved by the Invention] However, by the above washing methods, there were the following troubles by arranging much these using a flush tank.

[0007] (1) In order to put a high concentration drug solution into a flush tank and to always hold under an elevated temperature, when the flush tank which adjoins the \*\* by drug solution evaporation from an oil level etc. is polluted or a semi-conductor substrate is left near [ the ] the flush tank, possibility that a substrate front face will be polluted with a steam is high. Contamination especially by ammonia poses a

concrete problem. (2) Moreover, there is a fault that drug solution consumption is large. This becomes remarkable when a semi-conductor substrate diameter[ of macrostomia ]-izes, and the capacity of \*\* serves as 28l. of medicine a 6 inch substrate's processing case. (3) For the evaporation drug solution exhaust air described above, a large-sized exclusion facility is required, and it becomes cost quantity. (4) Since the capacity of a flush tank is large, there are also many amounts of the pure water used for rinsing by the overflow after each drug solution processing as 1 \*\*\*\* 30 L/min. (5) Moreover, since it has a drug solution tub / rinse tank, and each processing tub, equipment becomes large-sized and the occupancy area in a clean room also becomes large.

[0008] Therefore, the purpose of this invention is solving such a trouble, attaining the miniaturization of equipment, saving a high concentration drug solution, reducing the amount of the pure water used, and offering the substrate washing approach and substrate washing station about the low-temperature washing approach of a semi-conductor substrate with still less cross contamination.

[0009]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the substrate washing approach of this invention according to claim 1 rotates a substrate, and it includes the process which carries out the regurgitation of the dissolved hydrogen water on the surface of a substrate, and the process which removes discharge and dissolved hydrogen water for pure water to a substrate, impressing a supersonic wave to the dissolved hydrogen water which added hydrogen gas to pure water.

[0010] Thus, the particle on a substrate and a pollutant are removable by rotating a substrate, and carrying out the regurgitation of the dissolved hydrogen water of the ordinary temperature which gave supersonic vibration to a substrate, since the process which carries out the regurgitation of the dissolved hydrogen water on the surface of a substrate, and the process which removes discharge and dissolved hydrogen water for pure water to a substrate are included impressing a supersonic wave to the dissolved hydrogen water which added hydrogen gas to pure water. At this time, while many microbubbles occur very much [ a dimension with the hydrogen detailed in an operation of a supersonic wave which was dissolving especially on the substrate ], the radical of hydrogen occurs. Since dissolved hydrogen water exists also around contaminants, such as a particle / organic substance, a metal, etc. on a substrate, the microbubble of hydrogen, a hydrogen radical, etc. are made to the surroundings of a contaminant by this micro bubbling effectiveness, and it is thought that lift-off removal of the contaminant is carried out by this. Since this is made in ordinary temperature, contamination by the drug solution steam is reduced. From the batch immersion method immersed in a drug solution, the amount of dissolved hydrogen water and the pure water used can be reduced by making it the washing method of single wafer processing to a substrate still like before, and the miniaturization of equipment is also attained.

[0011] In claim 1, the hydrogen concentration of dissolved hydrogen water of the substrate washing approach according to claim 2 is 1.0-1.5 ppm. Thus, the micro bubbling effectiveness of hydrogen improves because the hydrogen concentration of dissolved hydrogen water sets to 1.0-1.5 ppm. That is, when the hydrogen concentration of dissolved hydrogen water is 1 ppm or less, an elimination factor worsens due to the amount of radical formation, and a high pressure is needed for making it dissolved at the time of 1.5 ppm or more. Moreover, since the particle removal engine performance will also be in a saturation state, the need of the concentration of 1.5 ppm or more is lost.

[0012] The substrate washing station according to claim 3 equipped the dissolved hydrogen water which carries out the regurgitation of the pivotable substrate installation base where a substrate is fixed, and the dissolved hydrogen water which added hydrogen gas to pure water to the dissolved hydrogen water regurgitation means which carries out the regurgitation to one front face of a substrate with an ultrasonic supply means to supply a supersonic wave.

[0013] Thus, the low-temperature washing method and ultrasonic supply means using a dissolved hydrogen water regurgitation means are provided, and since the dissolved hydrogen water which supplied the supersonic wave was breathed out on one front face of a substrate, even if it does not use a high concentration drug solution like before, removal of the particle on a substrate and a pollutant can be performed. For this reason, a substrate front face is not polluted by high concentration drug solution evaporation etc. And in addition to this, a substrate is not further immersed in a drug solution like before, but since one substrate is made to breathe out dissolved hydrogen water at a time, the amount of the drug solution used is sharply reducible. Moreover, the miniaturization of equipment is attained in addition to this, and the throughput of washing is also improvable.

[0014] The substrate washing station according to claim 4 was equipped with the pivotable substrate installation base where a substrate is fixed, the dissolved hydrogen water regurgitation means which carries out the regurgitation of the dissolved hydrogen water which added hydrogen gas to pure water to the front face and rear face of a substrate, and an ultrasonic supply means to supply a supersonic wave to the dissolved hydrogen water which carries out the regurgitation to the front face and rear face of a substrate.

[0015] Thus, the low-temperature washing method and ultrasonic supply means using a dissolved hydrogen water regurgitation means are provided, and since the dissolved hydrogen water which supplied the supersonic wave was breathed out at the front face and rear face of a substrate, even if it does not use a high concentration drug solution like before, removal of the particle on a substrate and a pollutant can be performed. For this reason, a substrate front face is not polluted by high concentration drug solution evaporation etc. And the amount of the drug solution used is sharply reducible by making it the double-sided washing method of single wafer processing which makes one substrate breathe out dissolved hydrogen water at a time rather than immersing a substrate in a drug solution like before further in addition to this. Moreover, the miniaturization of equipment is attained in addition to this, and the throughput of washing is also improvable.

[0016] The substrate washing station according to claim 5 was equipped with the pure-water regurgitation means which carries out the regurgitation of the pure water to the front face and rear face of a substrate in claims 4 or 5. Thus, since it has the pure-water regurgitation means which carries out the regurgitation of the pure water to the front face and rear face of a substrate, the dissolved hydrogen water which was used at the washing process and which remains is removable.

[0017]  
[Embodiment of the Invention] The gestalt of implementation of this invention is explained based on drawing 1. Drawing 1 shows the sectional view of the semi-conductor substrate washing station of single wafer processing used when enforcing the substrate washing approach of the gestalt implementation this invention. The washing approach of the gestalt this operation is the approach of washing using the liquid fundamentally called the dissolved hydrogen water which dissolved hydrogen gas in fixed concentration into pure water. As for hydrogen concentration, it is desirable that it is 1.0 to 1.5 ppm. The dissolved hydrogen water regurgitation nozzle which 1 possesses a semi-conductor substrate, and 2 possesses an ultrasonic supply function, and carries out the regurgitation of the pure water on the surface of a substrate in drawing 1, and 3 are the pure-water regurgitation nozzles for rinses possessing an ultrasonic supply function, and 4 is the object N2 for desiccation. A gas regurgitation nozzle and 5 are the substrate installation bases which fix a semi-conductor substrate, i.e., the chuck section. The thing of a semi-conductor substrate for which the chuck section 5 rotates a center section as a shaft mostly is possible. The nozzle for semi-conductor substrate rear-face washing in which 6 has the capacity which a supersonic wave is made to \*\*\*\*, and 7 are processing chambers. The dissolved hydrogen regurgitation nozzle 2 and the nozzle 6 for semi-conductor substrate rear-face washing carry out the regurgitation of the dissolved hydrogen water which added hydrogen gas to pure water to the front face and rear face of a substrate. In this case, the nozzle 6 for semi-conductor substrate rear-face washing can carry out the regurgitation of the pure water to a substrate rear face apart from dissolved hydrogen water. Although the source of an ultrasonic oscillation is not illustrated, it is located in the location distant from the dissolved hydrogen water regurgitation nozzle 2, the pure-water regurgitation nozzle 3, and the nozzle 6 for rear-face washing, and is connected with these nozzles.

[0018] The actuation and the washing treatment process of a semi-conductor substrate washing station which were constituted as mentioned above next and which use dissolved hydrogen water are explained. First, if the semi-conductor substrate 1 is set to the chuck section 5 in a chamber 7, rotating the semi-conductor substrate 1 by 500rpm, from the regurgitation nozzle 2, the front face of the semi-conductor substrate 1 was able to be beforehand decided with the amount discharge of requests, and time amount washing of the dissolved hydrogen water with a hydrogen concentration of 1.2 ppm of the ordinary temperature (25 degrees C) which was able to give the supersonic vibration of 1.6MHZ will be carried out. The period of this process and the dissolved hydrogen water regurgitation nozzle 2 are reciprocating the between from the core of the semi-conductor substrate 1 to a periphery at least on the front face of the semi-conductor substrate 1, and dissolved hydrogen water hits the whole front face of the semi-conductor substrate 1 together with rotation of a substrate.

[0019] On the semi-conductor substrate 1, in an operation of the supersonic wave with which the hydrogen which was dissolving was added to the regurgitation nozzle 2, while many microbubbles occur very much [ a detailed dimension ], the radical of hydrogen occurs especially in this process. Since dissolved hydrogen water exists also around contaminants, such as a particle / organic substance, a metal, etc. on the semi-conductor substrate 1, the microbubble of hydrogen, a hydrogen radical, etc. are made to the surroundings of a contaminant by this micro bubbling effectiveness, and it is thought that lift-off removal of the contaminant is carried out by this. That is, with the gestalt of this operation, the cleaning effect of the semi-conductor substrate 1 is acquired with the dissolved hydrogen water with which the supersonic wave was added. At this time, the rear face of the amount discharge of requests and the semi-conductor substrate 1 also washes dissolved hydrogen water with a hydrogen concentration of 1.2 ppm to coincidence from the fixed nozzle 6 for rear-face washing whose rear-face side of the semi-conductor substrate 1 was also made to \*\*\*\* supersonic vibration of 1.6MHZ(s) to coincidence. Moreover, when the hydrogen concentration of dissolved hydrogen water is 1 ppm or less, an elimination factor worsens due to the amount of radical formation, and a high pressure is needed for making it dissolved at the time of 1.5 ppm or more. Moreover, since the particle removal engine performance will also be in a saturation state, the need of the concentration of 1.5 ppm or more is lost. Therefore, hydrogen concentration was set to 1.2 ppm with the gestalt of this operation.

[0020] While rotating the semi-conductor substrate 1 by 1000rpm after an appropriate time, the dissolved hydrogen water which carried out the amount regurgitation of requests of the pure water for rinses, and used it for the semi-conductor substrate 1 at the washing process from the pure-water regurgitation nozzle 3 and the nozzle 6 for rear-face washing and which remains is removed. The period of this process and the regurgitation nozzle 3 are reciprocating the between from the core of a semi-conductor substrate to a periphery at least on the front face of the semi-conductor substrate 1, and the pure water for rinses hits the whole front face of the semi-conductor substrate 1. Then, it is the object N2 for desiccation from the regurgitation nozzle 4, rotating the semi-conductor substrate 1 by 1500rpm. After drying the front face of the discharge semi-conductor substrate 1 for gas, the semi-conductor substrate 1 is removed and it takes out from the chuck section 5 from the processing chamber 7.

[0021] As explained above, dissolved hydrogen water washes the washing approach of the gestalt this operation first. By this approach, all pollutants, such as a particle on a semi-conductor substrate, the organic substance, and a metal, are removable with one kind of dissolved hydrogen water, and since a semi-conductor substrate front face sees atomically and hydrogen termination is carried out with carrying out at a room temperature moreover, and hydrogen gas, chemical oxide hardly grows. It becomes unnecessary therefore, to remove the above-mentioned oxide using the fluoric acid which was the need conventionally. Moreover, it cannot be overemphasized that neither the hydrogen peroxide solution which is the conventional high concentration drug solution, nor ammonia, a sulfuric acid, etc. almost have the need.

[0022] Moreover, since a room temperature and dissolved hydrogen water wash, steams, such as ammonia, do not occur, but the contamination to the drug solutions which were problems conventionally, or a semi-conductor substrate from a drug solution can be prevented, and a large-scale exhaust air facility does not have the need, either.

[0023] Furthermore, since it is the single-wafer-processing processing which performs washing for removing a pollutant with the gestalt of this operation, and a rinse for every one semi-conductor substrate, the amount of the drug solution for washing or pure water is made to about about 1 / 10 as compared with the conventional batch immersion method. An advantage -- in connection with this, since the various flush tanks with a large capacity are unnecessary, equipment itself can be miniaturized, and occupancy area of an installation can also be made small -- is large.

[0024] In addition, although the rear-face washing leaf nozzle serves as the pure-water regurgitation nozzle, it may be constituted separately.

[0025]  
[Effect of the Invention] Impressing a supersonic wave to the dissolved hydrogen water which was made to rotate a substrate and added hydrogen gas to pure water according to the substrate washing approach of this invention according to claim 1 Since the process which carries out the regurgitation of this dissolved hydrogen water on the surface of a substrate, and the process which removes discharge and dissolved hydrogen water for pure water to a substrate are included, the particle on a substrate and a pollutant are removable by carrying out the regurgitation of the dissolved hydrogen water of the ordinary temperature

which gave supersonic vibration to a substrate. At this time, while many microbubbles occur very much [ a dimension with the hydrogen detailed in an operation of a supersonic wave which was dissolving especially on the substrate ], the radical of hydrogen occurs. Since dissolved hydrogen water exists also around contaminants, such as a particle / organic substance, a metal, etc. on a substrate, the microbubble of hydrogen, a hydrogen radical, etc. are made to the surroundings of a contaminant by this micro bubbling effectiveness, and it is thought that lift-off removal of the contaminant is carried out by this. Since this is made in ordinary temperature, contamination by the drug solution steam is reduced. From the batch immersion method immersed in a drug solution, the amount of dissolved hydrogen water and the pure water used can be reduced by making it the washing method of single wafer processing to a substrate still like before, and the miniaturization of equipment is also attained.

[0026] At claim 2, the micro bubbling effectiveness of hydrogen improves because the hydrogen concentration of dissolved hydrogen water sets to 1.0–1.5 ppm.

[0027] Since the dissolved hydrogen water which possessed the low-temperature washing method and ultrasonic supply means using a dissolved hydrogen water regurgitation means, and supplied the supersonic wave was breathed out on one front face of a substrate according to the substrate washing station of this invention according to claim 3, even if it does not use a high concentration drug solution like before, removal of the particle on a substrate and a pollutant can be performed. For this reason, a substrate front face is not polluted by high concentration drug solution evaporation etc. And in addition to this, a substrate is not further immersed in a drug solution like before, but since one substrate is made to breathe out dissolved hydrogen water at a time, the amount of the drug solution used is sharply reducible. Moreover, the miniaturization of equipment is attained in addition to this, and the throughput of washing is also improvable. The shift to the low-temperature washing process of the high concentration/high temperature processing which is the conventional semi-conductor substrate washing method from an RCA process can be performed by this, and contamination by the washing drug solution can be prevented by adoption of single-wafer-processing processing, and it is effective in the ability to reduce the amount of washing drug solutions, and exhaust air facility cost.

[0028] Since the dissolved hydrogen water which possessed the low-temperature washing method and ultrasonic supply means using a dissolved hydrogen water regurgitation means, and supplied the supersonic wave was breathed out at the front face and rear face of a substrate according to the substrate washing station of this invention according to claim 4, even if it does not use a high concentration drug solution like before, removal of the particle on a substrate and a pollutant can be performed. For this reason, a substrate front face is not polluted by high concentration drug solution evaporation etc. And the amount of the drug solution used is sharply reducible by making it the double-sided washing method of single wafer processing which makes one substrate breathe out dissolved hydrogen water at a time rather than immersing a substrate in a drug solution like before further in addition to this. Moreover, the miniaturization of equipment is attained in addition to this, and the throughput of washing is also improvable. The shift to the low-temperature washing process of the high concentration/high temperature processing which is the conventional semi-conductor substrate washing method like claim 3 from an RCA process can be performed by this, and contamination by the washing drug solution can be prevented by adoption of single-wafer-processing processing, and it is effective in the ability to reduce the amount of washing drug solutions, and exhaust air facility cost.

[0029] In claim 5, since it has the pure-water regurgitation means which carries out the regurgitation of the pure water to the front face and rear face of a substrate, the dissolved hydrogen water which was used at the washing process and which remains is removable.

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[Translation done.]



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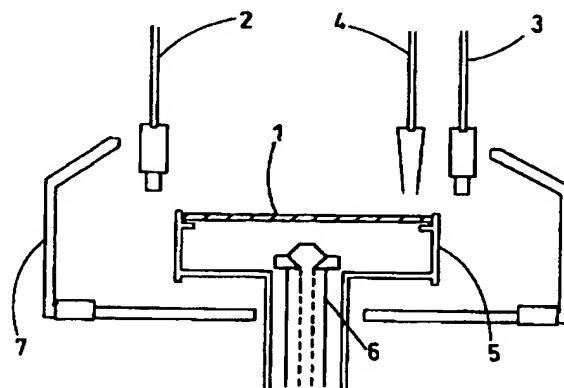
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(54) 【発明の名称】 基板洗浄方法および基板洗浄装置

(57) 【要約】

【課題】 装置の小型化を図り高濃度薬液を節約し、純水の使用量を低減し、さらに相互汚染の少ない、半導体基板の低温洗浄方法に関する。

【解決手段】 基板1が固定される回転可能な基板載置台5と、純水に水素ガスを添加した溶存水素水を基板1の一表面に吐出する溶存水素水吐出手段2、6と、吐出する溶存水素水に超音波を供給する超音波供給手段と、純水を基板1の表面および裏面に吐出する純水吐出手段3とを備えており、超音波振動を与えた常温の溶存水素水を基板1に吐出することにより、水素のマイクロバブリング効果で基板上の粒子、汚染物質を除去することができる。これは常温でできるので薬液蒸気による汚染が低減される。さらに従来のように基板に薬液を浸漬するパッチ浸漬方式から、枚葉式の洗浄方式にすることにより、溶存水素水、純水の使用量が低減でき装置の小型化も達成される。



1…半導体基板  
2…溶存水素水吐出ノズル  
3…リンス用純水吐出ノズル  
4…乾燥用N<sub>2</sub>ガス吐出ノズル

5…半導体基板チャック部  
6…裏面洗浄用ノズル  
7…処理チャンバ

## 【特許請求の範囲】

【請求項1】 基板を回転させ、純水に水素ガスを添加した溶存水素水に超音波を印加しつつ、前記溶存水素水を前記基板の表面に吐出する工程と、純水を前記基板に吐出し、前記溶存水素水を除去する工程とを含む基板洗浄方法。

【請求項2】 溶存水素水の水素濃度が1.0～1.5ppmである請求項2記載の基板洗浄方法。

【請求項3】 基板が固定される回転可能な基板載置台と、純水に水素ガスを添加した溶存水素水を前記基板の一表面に吐出する溶存水素水吐出手段と、前記吐出する溶存水素水に超音波を供給する超音波供給手段とを備えた基板洗浄装置。

【請求項4】 基板が固定される回転可能な基板載置台と、純水に水素ガスを添加した溶存水素水を前記基板の表面および裏面に吐出する溶存水素水吐出手段と、前記基板の表面および裏面に吐出する溶存水素水に超音波を供給する超音波供給手段とを備えた基板洗浄装置。

【請求項5】 純水を基板の表面および裏面に吐出する純水吐出手段を備えた請求項4または5記載の基板洗浄装置。

## 【発明の詳細な説明】

【0001】

【発明の属する技術分野】この発明は、半導体基板の洗浄についての基板洗浄方法および基板洗浄装置に関するものである。

【0002】

【従来の技術】半導体基板の、酸化・熱処理前、膜堆積前などの行う洗浄は様々なものがあるが一般に広く用いられているものとしてRCAプロセスと呼ばれる基板を数十枚まとめてバッチで浸漬するスタイルの洗浄方式がある。従来技術の一例として、このRCAプロセスの洗浄方式を図面を参照しながら説明する。

【0003】図2はRCAプロセスに使用される一連の洗浄槽の一般的な構成を示す図である。洗浄槽は高濃度薬液（アンモニア／過酸化水素水混合液または硫酸／過酸化水素水混合液）を入れ、高温加熱（通常70℃～80℃または130℃～140℃）で使用するものであって、各洗浄槽は半導体基板上に形成された被洗浄材料物質によって区別されている。例えば、8は有機物及び金属除去を目的とした硫酸／過酸化水素水（130℃～140℃）の混合薬液槽である。有機物とは例えばアッシャーで処理後半導体基板に残留したレジスト残りなどが該当する。9は薬液処理後の水洗槽、10はケミカルオキシド除去を目的とした弗酸槽である。ここでケミカルオキシドは、硫酸／過酸化水素水など酸化性の薬液で半導体基板を処理したときに表面に成長する薄い酸化膜をいう。

【0004】11は弗酸処理後の水洗槽であり、12は半導体基板表面に付着した粒子除去を目的としたアンモ

ニア／過酸化水素水／純水（70℃～80℃）の混合液槽、13は薬液処理後の水洗槽、14はケミカルオキシド除去を目的とした弗酸槽、15は弗酸処理後の最終水洗槽、16は乾燥用スピンドライヤである。

【0005】図2の構成では、概して2系統の洗浄処理に分けることができる。1つは洗浄槽8による処理から始まり、洗浄槽11で終わる半導体基板表面上の汚染などを除去・洗浄する工程、他は洗浄槽12による処理から始まり、洗浄槽15で終わる主として粒子除去を行う工程である。上記に説明したとおりに各種の槽が並べられているが、半導体デバイスの種類や洗浄目的、操作性等を考慮して並べる順番は適宜変更されるものである。

【0006】

【発明が解決しようとする課題】しかしながら上記のような洗浄方式では、洗浄槽を用い、これらを多数配列することによる次のような問題点があった。

【0007】（1）洗浄槽に高濃度薬液を入れ、常時高温下で保持するため、液面からの薬液蒸発等によってその槽に隣接する洗浄槽が汚染されたり、その洗浄槽近くに半導体基板を放置したとき、基板表面が蒸気で汚染される可能性が高い。特にアンモニアによる汚染が具体的問題となっている。（2）また、薬液消費量が大きいという欠点がある。これは半導体基板が大口径化したときに顕著になるものであって、例えば6インチ基板の処理場合、槽の容量は薬28リットルとなる。（3）上に述べた蒸発薬液排気のためには大型な除外設備が必要でありコスト高になる。（4）洗浄槽の容量が大きいため、各薬液処理後のオーバーフローによる水洗に使用する純水の量も一槽約30L/minと多い。（5）また、薬液槽／水洗槽と各処理槽を有するために装置が大型となり、クリーンルームでの占有面積も大きくなる。

【0008】したがって、この発明の目的は、このような問題点を解決するものであり、装置の小型化を図り高濃度薬液を節約し、純水の使用量を低減し、さらに相互汚染の少ない、半導体基板の低温洗浄方法に関する基板洗浄方法および基板洗浄装置を提供することである。

【0009】

【課題を解決するための手段】上記課題を解決するために、この発明の請求項1記載の基板洗浄方法は、基板を回転させ、純水に水素ガスを添加した溶存水素水に超音波を印加しつつ、溶存水素水を基板の表面に吐出する工程と、純水を基板に吐出し、溶存水素水を除去する工程とを含む。

【0010】このように、基板を回転させ、純水に水素ガスを添加した溶存水素水に超音波を印加しつつ、溶存水素水を基板の表面に吐出する工程と、純水を基板に吐出し、溶存水素水を除去する工程とを含むので、超音波振動を与えた常温の溶存水素水を基板に吐出することにより、基板上の粒子、汚染物質を除去することができ、このとき、特に基板上で溶解していた水素が超音波

の作用で、微細な寸法の非常に多数のマイクロバブルが発生するとともに水素のラジカルが発生する。基板上の粒子／有機物及び金属など汚染物質の周辺にも溶存水素水が存在するからこのマイクロバブリング効果で汚染物質の周りに水素のマイクロバブル、水素ラジカルなどができ、これによって汚染物質がリフトオフ除去されと  
考えられる。これは常温でできるので薬液蒸気による汚染が低減される。さらに従来のように基板に薬液を浸漬するパッチ浸漬方式から、枚葉式の洗浄方式にすることにより、溶存水素水、純水の使用量が低減でき装置の小型化も達成される。

【0011】請求項2記載の基板洗浄方法は、請求項1において、溶存水素水の酸素濃度が1.0～1.5ppmである。このように、溶存水素水の酸素濃度が1.0～1.5ppmとすることで水素のマイクロバブリング効果が向上する。すなわち、溶存水素水の酸素濃度が1ppm以下のとき、ラジカル生成量の関係で除去率が悪くなり、1.5ppm以上のとき、溶存させるのに高い圧力が必要となる。また、パーティクル除去性能も飽和状態となるため、1.5ppm以上の濃度は必要性がなくなる。

【0012】請求項3記載の基板洗浄装置は、基板が固定される回転可能な基板載置台と、純水に水素ガスを添加した溶存水素水を基板の一表面に吐出する溶存水素水吐出手段と、吐出する溶存水素水に超音波を供給する超音波供給手段とを備えた。

【0013】このように、溶存水素水吐出手段を用いた低温洗浄方式と超音波供給手段を具備し、超音波を供給した溶存水素水を基板の一表面に吐出したので、従来のような高濃度薬液を使用しなくても基板上の粒子、汚染物質の除去ができる。このため、基板表面が高濃度薬液蒸発等によって汚染されることがない。そしてさらにこれに加えて従来のように基板を薬液に浸漬するのではなく、基板に1枚ずつ溶存水素水を吐出させるので薬液の使用量を大幅に削減できる。またこれ以外に装置の小型化が図られ、洗浄のスループットも改善できる。

【0014】請求項4記載の基板洗浄装置は、基板が固定される回転可能な基板載置台と、純水に水素ガスを添加した溶存水素水を基板の表面および裏面に吐出する溶存水素水吐出手段と、基板の表面および裏面に吐出する溶存水素水に超音波を供給する超音波供給手段とを備えた。

【0015】このように、溶存水素水吐出手段を用いた低温洗浄方式と超音波供給手段を具備し、超音波を供給した溶存水素水を基板の表面および裏面に吐出したので、従来のような高濃度薬液を使用しなくても基板上の粒子、汚染物質の除去ができる。このため、基板表面が高濃度薬液蒸発等によって汚染されることがない。そしてさらにこれに加えて従来のように基板を薬液に浸漬するのではなく、基板に1枚ずつ溶存水素水を吐出させる

枚葉式の両面洗浄方式にすることにより、薬液の使用量を大幅に削減できる。またこれ以外に装置の小型化が図られ、洗浄のスループットも改善できる。

【0016】請求項5記載の基板洗浄装置は、請求項4または5において、純水を基板の表面および裏面に吐出する純水吐出手段を備えた。このように、純水を基板の表面および裏面に吐出する純水吐出手段を備えているので、洗浄工程で用いた残存する溶存水素水を除去することができる。

【0017】

【発明の実施の形態】この発明の実施の形態を図1に基づいて説明する。図1はこの発明の実施の形態の基板洗浄装置を実施するとき使用する枚葉式の半導体基板洗浄装置の断面図を示すものである。この実施の形態の洗浄方法は基本的には、純水中に水素ガスを一定の濃度に溶解した溶存水素水と呼ばれる液体を使用して洗浄する方法である。酸素濃度は1.0～1.5ppmであることが望ましい。図1において、1は半導体基板、2は超音波供給機能を具備し純水を基板の表面に吐出する溶存水素水吐出ノズル、3は超音波供給機能を具備したリンス用純水吐出ノズルであり、4は乾燥用N<sub>2</sub>ガス吐出ノズル、5は半導体基板を固定する基板載置台、すなわちチャック部である。チャック部5は半導体基板のほぼ中央部を軸として回転させることが可能である。6は超音波を伝播させる能力のある半導体基板裏面洗浄用ノズル、7は処理チャンバである。溶存水素水吐出ノズル2および半導体基板裏面洗浄用ノズル6は、純水に水素ガスを添加した溶存水素水を基板の表面および裏面に吐出する。この場合、半導体基板裏面洗浄用ノズル6は、溶存水素水とは別に純水を基板裏面に吐出することができる。超音波発振源は図示していないが、溶存水素水吐出ノズル2、純水吐出ノズル3、裏面洗浄用ノズル6から離れた場所であってこれらのノズルと接続されている。

【0018】つぎに上記のように構成された、溶存水素水を使用する半導体基板洗浄装置の動作及び洗浄処理プロセスについて説明する。まず、半導体基板1がチャンバ7内のチャック部5にセットされると、500rpmで半導体基板1を回転させながら、1.6MHzの超音波振動を与えられた常温(25℃)の、酸素濃度1.2ppmの溶存水素水を吐出ノズル2より所望量吐出しながら、半導体基板1の表面を予め決められた時間洗浄する。この工程の期間、溶存水素水吐出ノズル2は半導体基板1の表面上において少なくとも半導体基板1の中心部から周辺部までの間を往復運動していて、基板の回転運動と合わせて半導体基板1の表面全体に溶存水素水が当たるようになっている。

【0019】この過程では、特に半導体基板1上で、溶解していた水素が吐出ノズル2に加えられた超音波の作用で、微細な寸法の非常に多数のマイクロバブルが発生するとともに水素のラジカルが発生する。半導体基板1

上の粒子／有機物及び金属など汚染物質の周辺にも溶存水素水が存在するからこのマイクロバブリング効果で汚染物質の周りに水素のマイクロバブル、水素ラジカルなどができ、これによって汚染物質がリフトオフ除去されると考えられる。すなわち、この実施の形態では超音波が加えられた溶存水素水によって半導体基板1の洗浄効果を得るのである。この時、半導体基板1の裏面側も同時に1.6MHzの超音波振動を伝播させた固定された裏面洗浄用ノズル6より水素濃度1.2ppmの溶存水素水を所望量吐出し、半導体基板1の裏面も同時に洗浄する。また、溶存水素水の水素濃度が1ppm以下のとき、ラジカル生成量の関係で除去率が悪くなり、1.5ppm以上のとき、溶存させるのに高い圧力が必要となる。また、パーティクル除去性能も飽和状態となるため、1.5ppm以上の濃度は必要性がなくなる。そのため、この実施の形態では水素濃度を1.2ppmとした。

【0020】しかる後、半導体基板1を1000rpmで回転させるとともに、純水吐出ノズル3及び裏面洗浄用ノズル6より、リンス用純水を所望量吐出して半導体基板1に、洗浄工程で用いた残存する溶存水素水を除去する。この工程の期間、吐出ノズル3は半導体基板1の表面上において少なくとも半導体基板の中心部から周辺部までの間を往復運動していて、半導体基板1の表面全体にリンス用純水が当たるようになっている。この後、半導体基板1を1500rpmで回転させながら吐出ノズル4より乾燥用N<sub>2</sub>ガスを吐出し半導体基板1の表面を乾燥した後、チャック部5より半導体基板1を外し処理チャンバ7より取り出す。

【0021】以上説明したようにこの実施の形態の洗浄方法は、まず溶存水素水で洗浄する。この方法では、半導体基板上の粒子、有機物及び金属などの汚染物質すべてを溶存水素水1種類で除去することができ、しかも室温で行うこと、および水素ガスによって半導体基板表面が原子的に見て水素終端されるのでケミカルオキサイドがほとんど成長しない。従って従来必要であったフッ酸を用いて上記オキサイドを除去する必要がなくなる。また、従来の高濃度薬液である過酸化水素水やアンモニア、硫酸などはほとんど必要がないことはいうまでもない。

【0022】また、洗浄を室温かつ溶存水素水で行うので、アンモニアなどの蒸気が発生せず、従来問題であった薬液どうし、あるいは薬液から半導体基板への汚染を防止でき、大規模な排気設備も必要がない。

【0023】さらに、この実施の形態では汚染物質を除去するための洗浄およびリンスを半導体基板1枚毎に行う枚葉式処理なので、洗浄用薬液あるいは純水の量が従来のバッチ浸漬方式と比較して約1/10程度にできる。これに伴い容量の大きい各種洗浄槽が必要ないので装置自体が小型化でき、設置場所の占有面積も小さくて

きるなど利点が多い。

【0024】なお、裏面洗浄用ノズルは純水吐出ノズルを兼ねているが、別々に構成してもよい。

【0025】

【発明の効果】この発明の請求項1記載の基板洗浄方法によれば、基板を回転させ、純水に水素ガスを添加した溶存水素水に超音波を印加しつつ、この溶存水素水を基板の表面に吐出する工程と、純水を基板に吐出し、溶存水素水を除去する工程とを含むので、超音波振動を与えた常温の溶存水素水を基板に吐出することにより、基板上の粒子、汚染物質を除去することができる。このとき、特に基板上で溶解していた水素が超音波の作用で、微細な寸法の非常に多数のマイクロバブルが発生するとともに水素のラジカルが発生する。基板上の粒子／有機物及び金属など汚染物質の周辺にも溶存水素水が存在するからこのマイクロバブリング効果で汚染物質の周りに水素のマイクロバブル、水素ラジカルなどができ、これによって汚染物質がリフトオフ除去されると考えられる。これは常温でできるので薬液蒸気による汚染が低減される。さらに従来のように基板に薬液を浸漬するバッチ浸漬方式から、枚葉式の洗浄方式にすることにより、溶存水素水、純水の使用量が低減でき装置の小型化も達成される。

【0026】請求項2では、溶存水素水の水素濃度が1.0～1.5ppmとすることで水素のマイクロバブリング効果が向上する。

【0027】この発明の請求項3記載の基板洗浄装置によれば、溶存水素水吐出手段を用いた低温洗浄方式と超音波供給手段を具備し、超音波を供給した溶存水素水を基板の一表面に吐出したので、従来のような高濃度薬液を使用しなくても基板上の粒子、汚染物質の除去ができる。このため、基板表面が高濃度薬液蒸発等によって汚染されることがない。そしてさらにこれに加えて従来のように基板を薬液に浸漬するのではなく、基板に1枚ずつ溶存水素水を吐出させるので薬液の使用量を大幅に削減できる。またこれ以外に装置の小型化が図られ、洗浄のスループットも改善できる。これにより従来の半導体基板洗浄方式である高濃度／高温処理のRCAプロセスから低温洗浄プロセスへの移行ができ、また枚葉式処理の採用によって洗浄薬液による汚染が防止でき、洗浄薬液量、排気設備コストが低減できるという効果がある。

【0028】この発明の請求項4記載の基板洗浄装置によれば、溶存水素水吐出手段を用いた低温洗浄方式と超音波供給手段を具備し、超音波を供給した溶存水素水を基板の表面および裏面に吐出したので、従来のような高濃度薬液を使用しなくても基板上の粒子、汚染物質の除去ができる。このため、基板表面が高濃度薬液蒸発等によって汚染されることがない。そしてさらにこれに加えて従来のように基板を薬液に浸漬するのではなく、基板に1枚ずつ溶存水素水を吐出させる枚葉式の両面洗浄方

式にすることにより、薬液の使用量を大幅に削減できる。またこれ以外に装置の小型化が図られ、洗浄のスループットも改善できる。これにより、請求項3と同様に従来の半導体基板洗浄方式である高濃度／高温処理のRCAプロセスから低温洗浄プロセスへの移行ができ、また枚葉式処理の採用によって洗浄薬液による汚染が防止でき、洗浄薬液量、排気設備コストが低減できるという効果がある。

【0029】請求項5では、純水を基板の表面および裏面に吐出する純水吐出手段を備えているので、洗浄工程で用いた残存する溶存水素水を除去することができる。

【図面の簡単な説明】

【図1】この発明の実施の形態の半導体基板洗浄装置の要部断面図である。

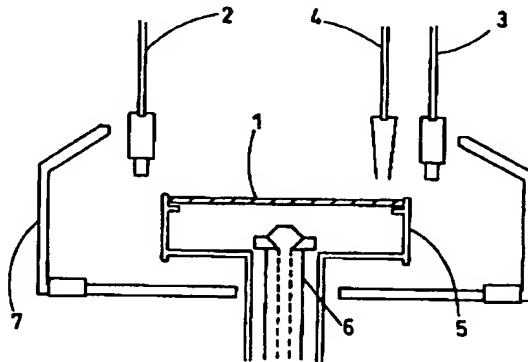
【図2】従来のRCAプロセスを使用し半導体基板洗浄装置の構成図である。

【符号の説明】

\*

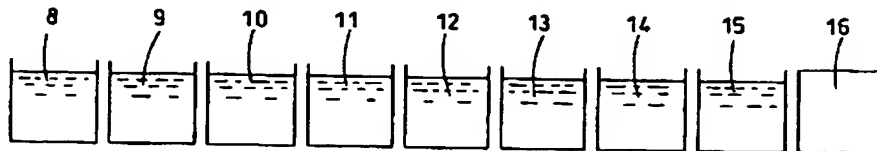
- \* 1 半導体基板
- 2 溶存水素水吐出ノズル
- 3 リンス用純水吐出ノズル
- 4 乾燥用N<sub>2</sub>ガス吐出ノズル
- 5 半導体基板チャック部
- 6 裏面洗浄用ノズル
- 7 処理チャンバ
- 8 硫酸／過酸化水素水槽
- 9 水洗槽
- 10 10 弗酸槽
- 11 水洗槽
- 12 アンモニア／過酸化水素水槽
- 13 水洗槽
- 14 弗酸槽
- 15 水洗槽
- 16 スピンドライヤ

【図1】



- 1…半導体基板
- 2…溶存水素水吐出ノズル
- 3…リンス用純水吐出ノズル
- 4…乾燥用N<sub>2</sub>ガス吐出ノズル
- 5…半導体基板チャック部
- 6…裏面洗浄用ノズル
- 7…処理チャンバ

【図2】



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